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ANALYSIS OF THE HIGH-ALTITUDE COOLING OF THE RANGER SGV-770 D-4 ENGINE IN THE BELL XP-77 AIRPLANE.

by

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MEMORANDUM REPORT

for the

Army Air Forces, Materiel Command

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SUMMARY

As a part of a general NACA investigation of the cooling of the Bell XP-77 airplane, an analysis has been made of the cooling installation in the high-altitude XP-77 airplane for the entire altitude range. The analysis has been based on heat-transfer data taken in the propeller-research tunnel on the Ranger SGV-770 C-1B engine. This engine was tested with the same cylinders, aluminum fins, and turbulent-flow baffles proposed for the high-altitude SGV-770 D-4 engine. The cowling pressure measurements used in the analysis were obtained in the propeller-research tunnel on the low-altitude version of the XP-77 airplane equipped with an NACA designed cowling. Other data have been supplied by the Bell Aircraft Corporation and Ranger Aircraft Engines. The most recent methods developed by the NACA at LMAL have been used in making the altitude predictions.

The calculations show that the pressure drop available is not sufficient to cool the engine in climb at military power above 15,000 feet. The low available pressure is due to the low airplane speed and the high air-flow losses.

Cooling in cruising power at 27,000 feet will be marginal. The high required pressure drops are due to the low barrel-flange temperature limit.

The smallest conventional oil cooler with 9-inch tubes 0.256 inch in internal diameter that will keep the oil inlet temperature to the engine below 185° F will have a diameter of 11 inches.

The modified lower lip of the NACA cowling has too low a critical speed for satisfactory operation in high-speed level flight at altitude. Further modifications have been made to the test airplane to remedy this defect.

INTRODUCTION

Late in 1942 the NACA at the request of the Army Air Forces and in close cooperation with the Bell Aircraft Corporation and Ranger Aircraft Engines began a general wind-tunnel investigation of the cooling of the Bell XP-77 airplane. A full-scale model of the airplane equipped with the low-altitude Ranger SGV-770 C-1 engine was tested in the propeller-research tunnel. The effects of several cowling configurations on the available cooling pressures and the air-flow losses were studied. In addition a heat-transfer correlation, based on the method of reference 1, was made for the C-1B engine with aluminum fins and turbulent-flow baffles. The final results of the cooling pressure measurements are presented in reference 2, and the final results of the heat-transfer correlations are presented in reference 3.

The general layout of the cooling installation in the XP-77 airplane has been described in reference 2. The power plant is an inverted-vee, 12-cylinder, air-cooled engine. Air for carburetion, engine cooling, and oil cooling enters the cowling directly behind the propeller. This arrangement permits full utilization of the slipstream pressure in cooling the engine. The low-altitude XP-77 airplane will be equipped with a Ranger SGV-770 C-1B engine. The C-1B engine has the aluminum fins and turbulent-flow baffles described in reference 2. The high-altitude XP-77 airplane will be equipped with a Ranger SGV-770 D-4 engine, which has a Planiol type supercharger. The D-4 engine will have the same cylinder and baffles as the C-1B engine.

The XP-77 airplane was tested in the propeller-research tunnel with both a Bell designed cowling and an NACA designed cowling. On the NACA designed cowling the cooling-air inlet was enlarged and reshaped. The engine air outlet was moved farther forward and equipped with guide vanes. The engine-cooling analysis and the critical-speed analysis are made from pressure measure-